REMARKS

Favorable reconsideration of this application is respectfully requested.

It is initially noted that with the previous Amendment filed October 31, 2002, an Information Disclosure Statement was filed citing an article to Visokay et al. At this time confirmation of consideration of that Information Disclosure Statement has not been made. Applicants respectfully request that it be confirmed on the record that that Information Disclosure Statement has been considered. For convenience, a copy of the filed Information Disclosure Statement, including the date-stamped filing receipt indicating its filing, is provided herewith.

Claims 4 and 17 are amended by the present response to make minor clarifications therein. The changes made to Claims 4 and 17 are not believed to raise any new issues that would preclude entry of the present amendment.

Claims 1-4, 6-9, and 12-26 are pending in this application. Claims 14 and 15 stand withdrawn from consideration. Claims 1-4, 7-9, 12, and 13 were rejected under 35 U.S.C. § 103(a) as unpatentable over U.S. patent 6,291,867 to Wallace et al. (herein "Wallace"). Claim 6 was rejected under 35 U.S.C. § 103(a) as unpatentable over Wallace in view of U.S. patent 4,432,035 to Hsieh et al. (herein "Hsieh"). Claims 16-19 and 21-25 were rejected under 35 U.S.C. § 103(a) as unpatentable over Wallace in view of the Background of the Invention. Claim 20 was rejected under 35 U.S.C. § 103(a) as unpatentable over Wallace as applied to Claim 16, and further in view of Hsieh. Claim 26 was rejected under 35 U.S.C. § 103(a) as unpatentable over Wallace as applied to Claim 16, and further in view of U.S. patent 5,818,092 to Bai et al. (herein "Bai").

Addressing now the rejection of Claims 1-4, 7-9, 12, and 13 under 35 U.S.C. § 103(a) as unpatentable over Wallace, that rejection is traversed by the present response.

The semiconductor device of independent Claim 1 includes a semiconductor substrate and a circuit element using an insulating film formed on the semiconductor substrate. The insulating film contains a silicon compound containing at least one element selected from the group consisting of an oxygen and a nitrogen, and a metal compound containing a metal other than silicon and at least one element selected from the group consisting of oxygen and nitrogen. Nano-crystals are formed in the insulating film, a particle diameter of the nano-crystals being within a range of between 1 nm and 10 nm.

The outstanding rejection based on Wallace is traversed as Wallace does not disclose a similar process as in the claimed invention with respect to determination of the diameter of the nano-crystals, as now discussed in further detail below.

The insulating film can be formed by a method, for example as described in the original specification at page 18, line 15, to page 19, line 4, with respect to the Example 1, disclosing a method of forming the insulating film containing Ti as a metal. As stated in that portion of the specification:

> In Example 1, the mixed film 22 was deposited by a sputtering method. To be more specific, a target is prepared by finely pulverizing TiO_2 and SiO_2, followed by sintering the pulverized materials mixed at a predetermined mixing ratio. The mixing ratio of Si/(Ti + Si) is set at 20%. After the target is positioned to face the silicon substrate, a sputtering was performed for 30 minutes under a mixed gas atmosphere of Ar and O_2 (Ar: 20 sccm; O_2: 2 sccm) so as to deposit the mixed film 22 in a thickness of 20 nm. The sputtering was performed at room temperature with the power set to 100 W.
>
> In the next step, a heat treatment was applied to the mixed film 22 at 800°C for 30 seconds under an Ar gas atmosphere so as to convert the mixed film 22 into a highly dielectric film 23 containing nano-crystals, as shown in FIG. 4B.

In addition, in the specification at page 22, lines 2-12, the description states:

> The present inventors have also found through extensive research, that the TiO_2/SiO_2 mixed film formed of nano-crystals exhibits a very high relative dielectric constant in the case where the silicon content of the mixed film is

> not lower than 15%. This is highly effective for the manufacture of the next generation LSIs, i.e., an LSI having a gate length Lg of 10 nm, in that it is possible to increase the capacitance between the gate and the substrate while suppressing the leakage current, i.e., power consumption of the LSI.

The above-noted structures are also supported by Figure 7 of the original specification.

The diameter of the nano-crystals, as recited in the claims as "being within a range of between 1 nm and 10 nm", may be appropriately controlled by the amount of Si. That is, the diameter of the nano-crystals can be controlled by setting the content of Si to be not lower than 15% based on the total amount of Si and the metal.

Such a fact as noted above was found, for the first time, by the present inventors. That subject matter is also noted in the original specification at page 16, line 26, to page 17, line 6, which states:

> ...nano-crystals are precipitated in the thin film. The particular construction of one embodiment of the present invention makes it possible to suppress the leakage current derived from the grain boundary and to suppress the non-uniformity in the threshold value and the driving force. It follows that it is possible to improve the characteristics of the MOS transistor, etc.

Accordingly, an insulating film is preferably used as a gate insulating film of a MOSFET.

The outstanding rejection recognizes that Wallace does not disclose the claimed particle diameter of the crystals. However, the outstanding Office Action has taken the position that "since the crystallizing temperature of Wallace is similar to that of the present invention, the nano-crystals grains form with the insulating film (36) of Wallace would have a similar diameter as claimed, similar process similar result".[2]

The above-noted basis for the outstanding rejection is traversed as Wallace does not in fact disclose the same process as in the claimed invention, and thereby Wallace does not

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[2]Office Action of January 14, 2003, page 3, lines 5-7.

produce similar results.

More particularly, as noted above controlling the Si content can control the diameter of the nano-crystals. Also, controlling a Si/metal mixed film to contain not lower than 15% of Si, which thereby controls the diameter of the nano-crystals, is not disclosed or suggested in Wallace. That is, Wallace does not pay any attention to the Si content. Thereby, it is respectfully submitted it is clear that the nano-crystals having a diameter within a range of between 1 nm and 10 nm are not disclosed, suggested, or even considered in Wallace. Moreover, Wallace does not disclose or suggest a method to form nano-crystals with a diameter between 1 nm and 10 nm as claimed, and it is respectfully submitted that in the device of Wallace the nano-crystals would not have such a diameter.

In Wallace there is no need nor motivation disclosed or suggested to control the Si content of an Si/metal mixed film to be not lower than 15%, and thereby the device of Wallace is not believed to result in a device with nano-crystals having a diameter "within a range of between 1 nm and 10 nm" as recited in the claims. Further, for the above reasons it is respectfully submitted that it is not the case that the device of Wallace has a similar process with respect to controlling the diameter of the nano-crystals.

In such ways, the claims are believed to clearly distinguish over the teachings in Wallace.

Further, with respect to the other rejections based on Wallace in view of Hsieh, Wallace in view of the background of the invention, and Wallace in view of Bai, those rejections are also traversed by the present response as none of the noted secondary references can overcome the above-noted deficiencies of Wallace.

As no other issues are pending in this application, it is respectfully submitted that the present application is now in condition for allowance, and it is hereby respectfully requested that this case be passed to issue.

Respectfully submitted,

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IN THE CLAIMS

4. (Twice Amended) The semiconductor device according to claim 2, wherein said nano-crystals are made of an oxide[, a nitride or an oxynitride or a metal other than silicon].

17. (Amended) The semiconductor device according to claim 16, wherein said silicon compound [is a compound selected from the group consisting of a] contains silicon oxide[, a silicon nitride, and a silicon oxynitride].

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OSMM&N File No. 210313US2SRD By: GJM/SS/SKK:dnf

Serial No. 09/891,129

In the matter of the Application of: Akira NISHIYAMA, et al.

For: SEMICONDUCTOR DEVICE AND METHOD OF MANUFACTURING TH SAME

Due Date: October 31, 2002

The following has been received in the U.S. Patent Office on the date stamped here

- ■ Check for $234.00
- ■ Dep. Acct. Order Form
- ■ Letter Requesting Approval of Drawing Changes w/ Figures 1, 2A and 2B
- ■ Amendment Cover Letter
- ■ Amendment with marked-up copy
- ■ Information Disclosure Statement
- ■ PTO-1449
- ■ Cited References 1

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